Upgrade options for Femtosource

Introduction

This time we want to fix the top beam energy for Berkeley Femtosource. This will allow us to finally settle with the machine lattice and to move into freezing of other machine parameters. Present lattice design allows 4 GeV (3.9 GeV actual operation energy since we may need extra margin for a magnetization loop). Present linac design allows 2.5 GeV. The decision about energy upgrade for the linac can be deferred, if it is permitted by lattice.

Here we present the background information needed for the decision making. We consider three beam energies: 2.5 GeV, 3.1 GeV and 3.8 GeV. For each energy we consider four types of undulators of increased technical difficulty. The assumed basic design for undulators is a superconducting in-vacuum undulator similar to Moser-Rosmanith's undulator. In all four cases the length of the undulator is 2 m, which is restricted by present lattice design. The main undulator characteristics are listed in the Table 1.

Table 1. Main undulator characteristics.

Type	Period, mm	Gap, mm	Peak magnetic field, T	Undulator parameter, K
1	20	5	1.5	2.8
2	14	5	1.5	2.0
3	14	3	2.0	2.6
4	10	3	1.5	1.4

) Types 2 and 3 can be covered with one undulator with the adjustable gap.

For all energy and undulator type cases we show results of the calculation of the x-ray flux (number of x-ray per second and per 0.1% bandwidth). Notice, that plots give flux for odd undulator harmonics from the first to the eleven harmonics. If correspondent neighboring curves do not interleave, then it means that it is not possible for a given maximum peak undulator field. For an electron beam we assume 10 kHz repetition rate and 1 nC per bunch. The normalized electron beam emittance is 20 mm-mrad in the horizontal plane and 0.4 mm-mrad in the vertical plane. The absolute energy spread is 150 keV. We also assumed 50m vertical beta-function in the deflecting RF structure and 2.5m and 7.5m vertical and horizontal beta-functions in the undulator. Using this parameters we calculate a compression of the x-ray pulse and plot FWHM of the x-ray pulse in fs for each beam energy.

à **Beam energy 2.5 GeV**

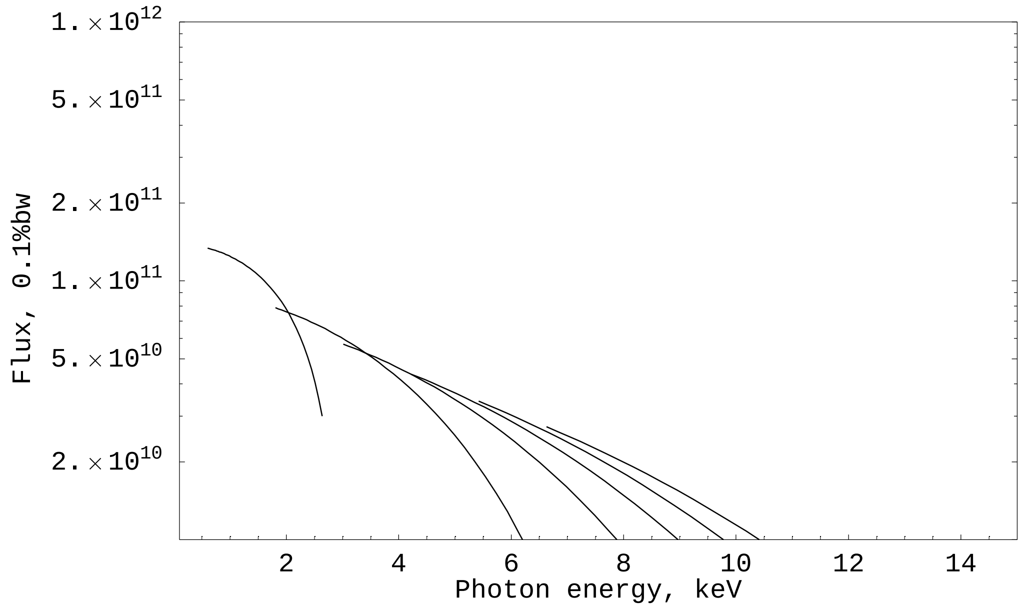

Figure 1. Kmax=2.8, period=2.0 cm (Gap=5 mm, Bpeak=1.5 T)

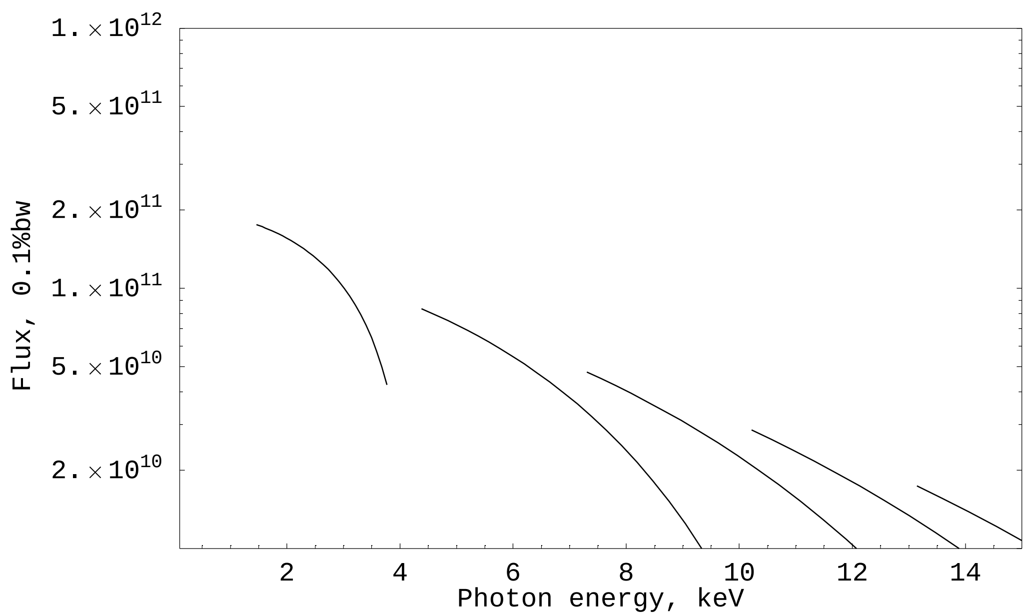

Figure 2. Kmax=2, period=1.4 cm (Gap=5 mm, Bpeak=1.5 T)

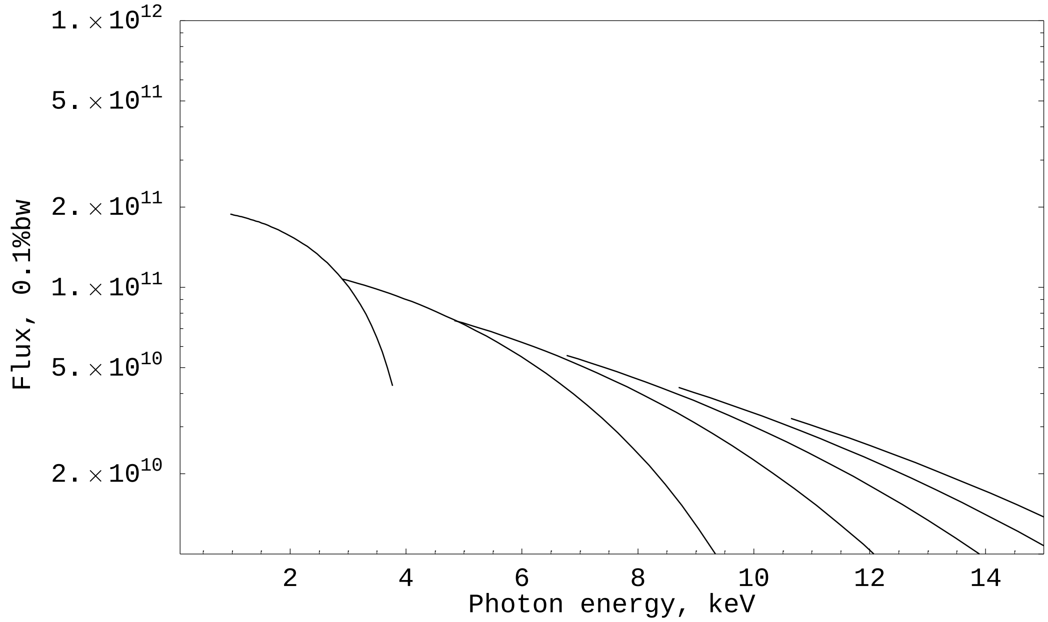

Figure 3. Kmax=2.6, period=1.4 cm (Gap=3 mm, Bpeak=2 T)

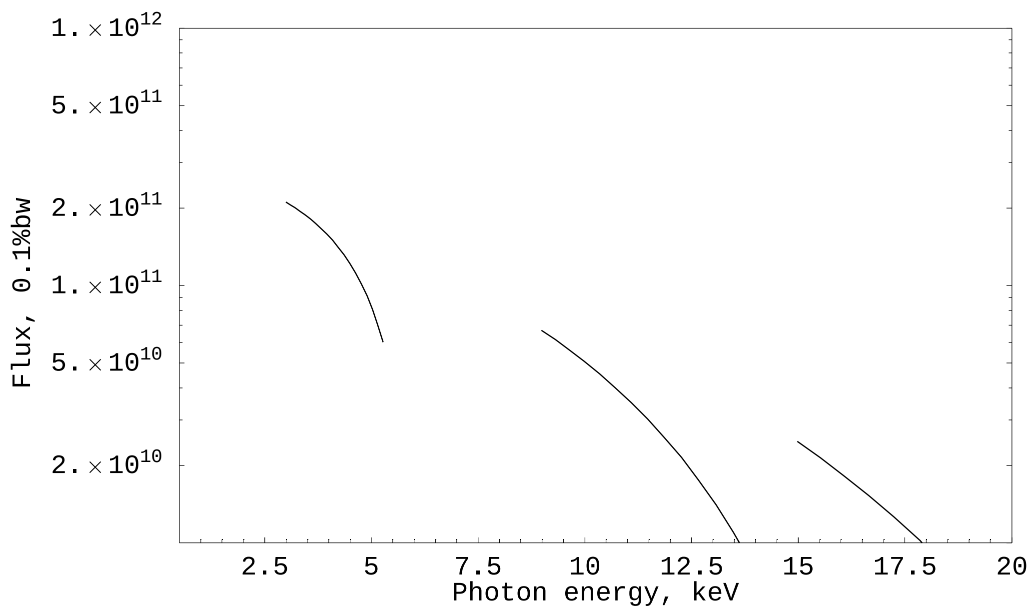

Figure 4. Kmax=1.4, period=1.0 cm (Gap=3 mm, Bpeak=1.5 T)

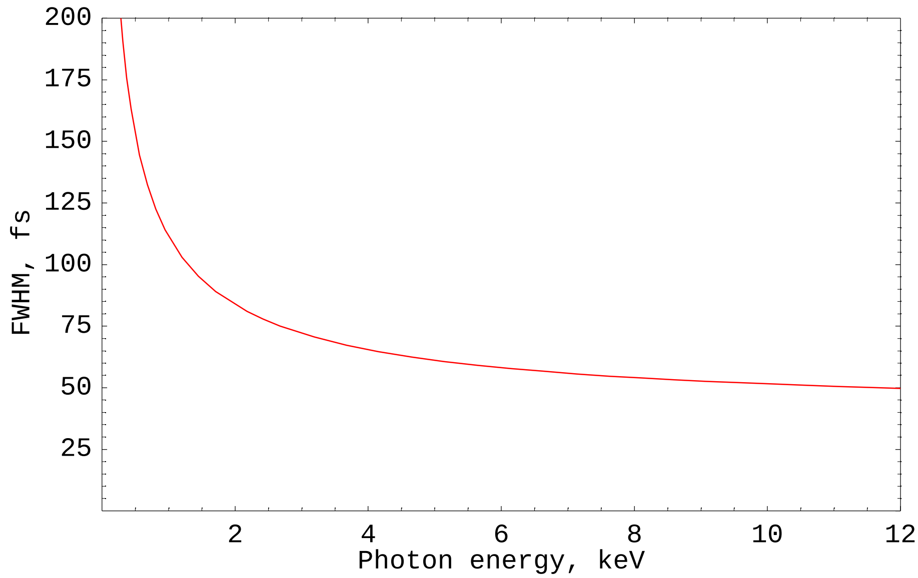

Figure 5. Beta_rf = 50m, Urf=7.4 MV, tilt angle = 160 microrad

à Beam energy 3.1 GeV

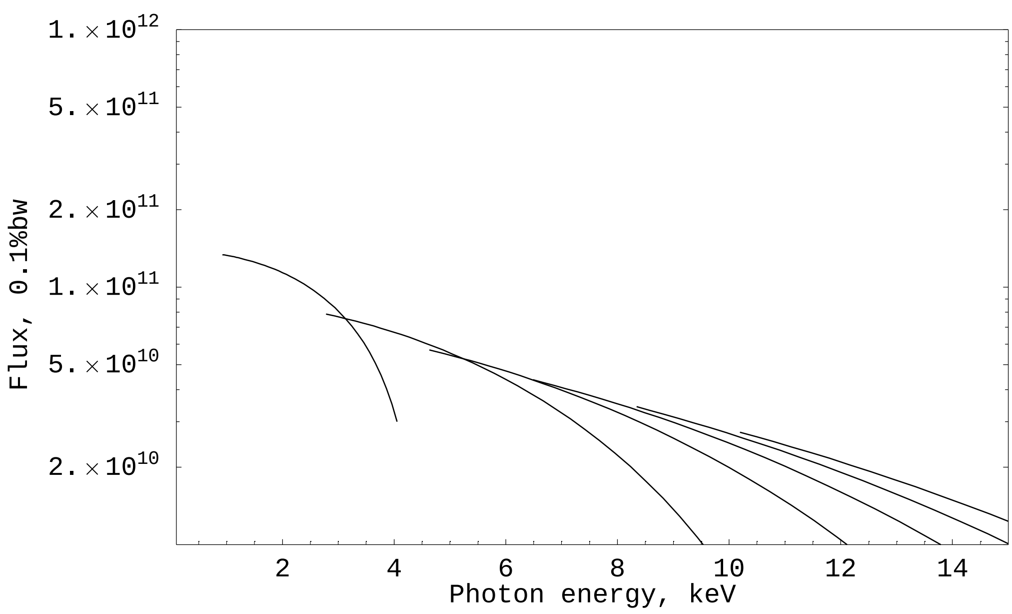

Figure 6. Kmax=2.8, period=2.0 cm (Gap=5 mm, Bpeak=1.5 T); (compare with Figure 1)

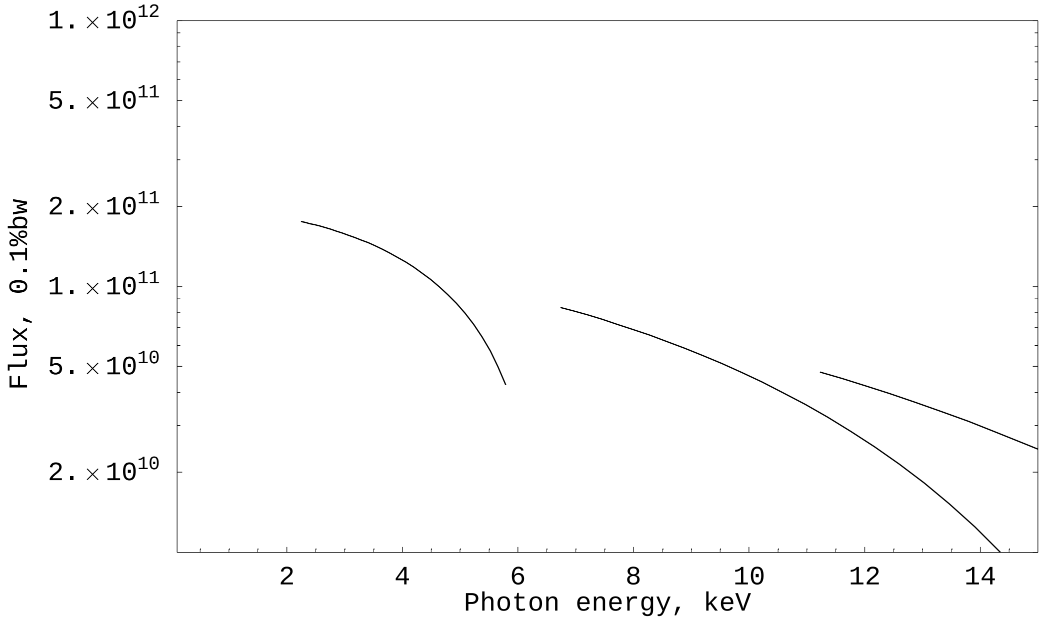

Figure 7. Kmax=2, period=1.4 cm (Gap=5 mm, Bpeak=1.5 T); (compare with Figure 2)

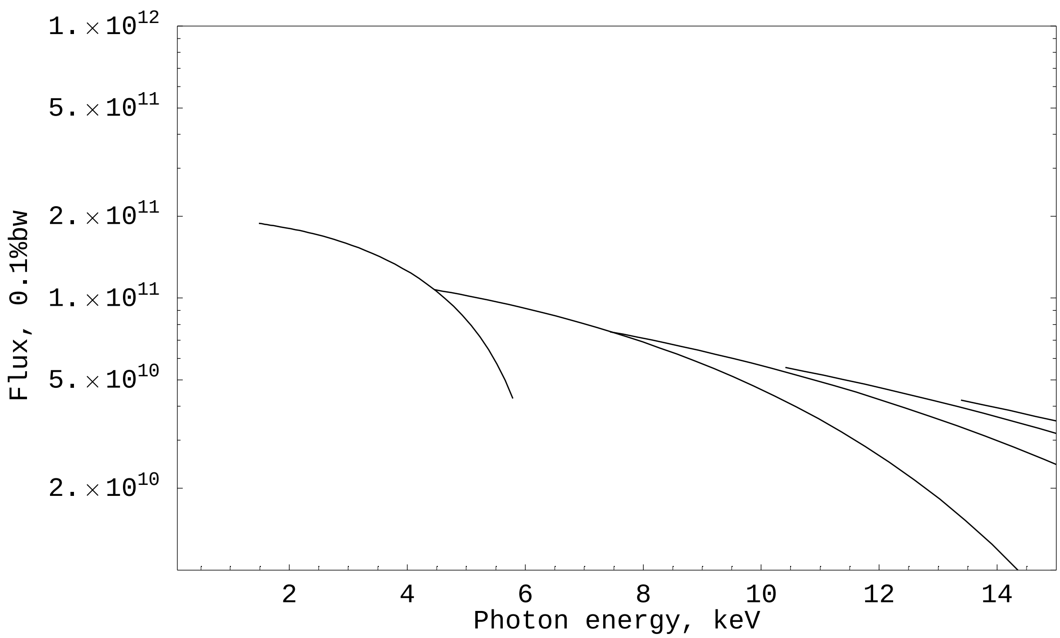

Figure 8. Kmax=2.6, period=1.4 cm (Gap=3 mm, Bpeak=2 T); (compare with Figure 3)

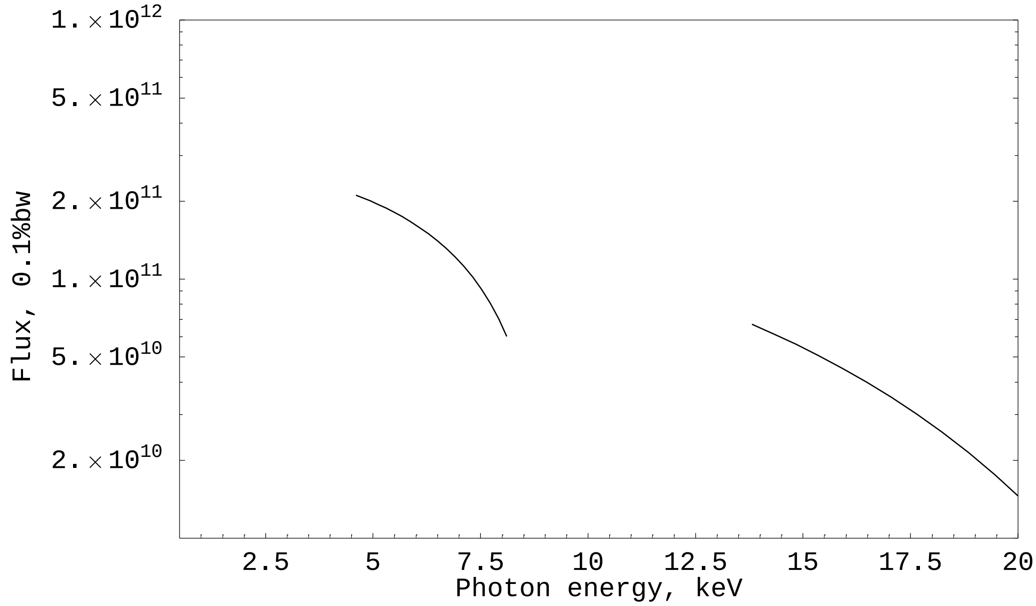

Figure9. Kmax=1.4, period=1.0 cm (Gap=3 mm, Bpeak=1.5 T); (compare with Figure 4)

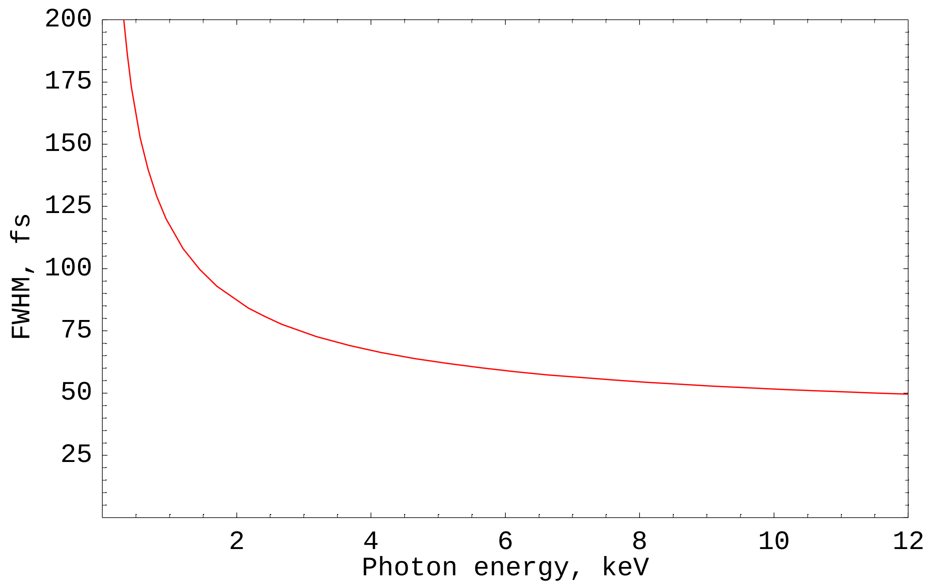

Figure 10. Beta_rf = 50m, Urf=8.5 MV, tilt angle = 150 microrad

à Beam energy 3.8 GeV

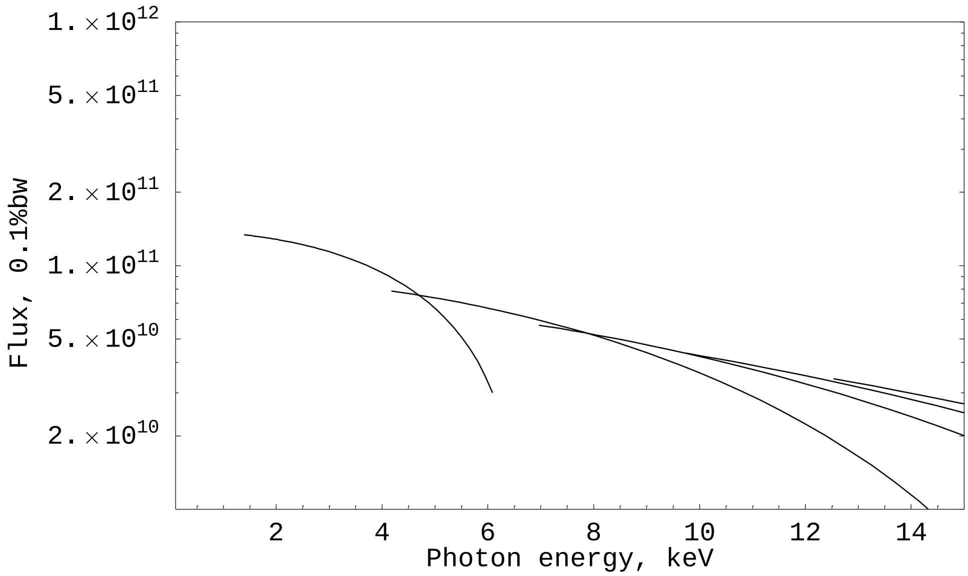

Figure 11. Kmax=2.8, period=2.0 cm (Gap=5 mm, Bpeak=1.5 T);   (compare with Figure 1 and 5)

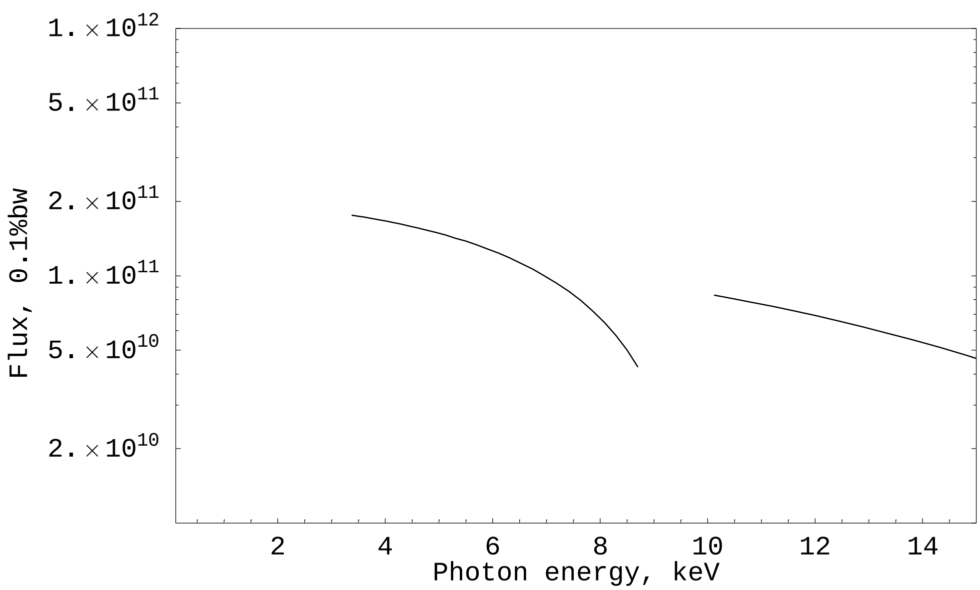

Figure 12. Kmax=2, period=1.4 cm (Gap=5 mm, Bpeak=1.5 T); (compare with Figure 2 and 6)

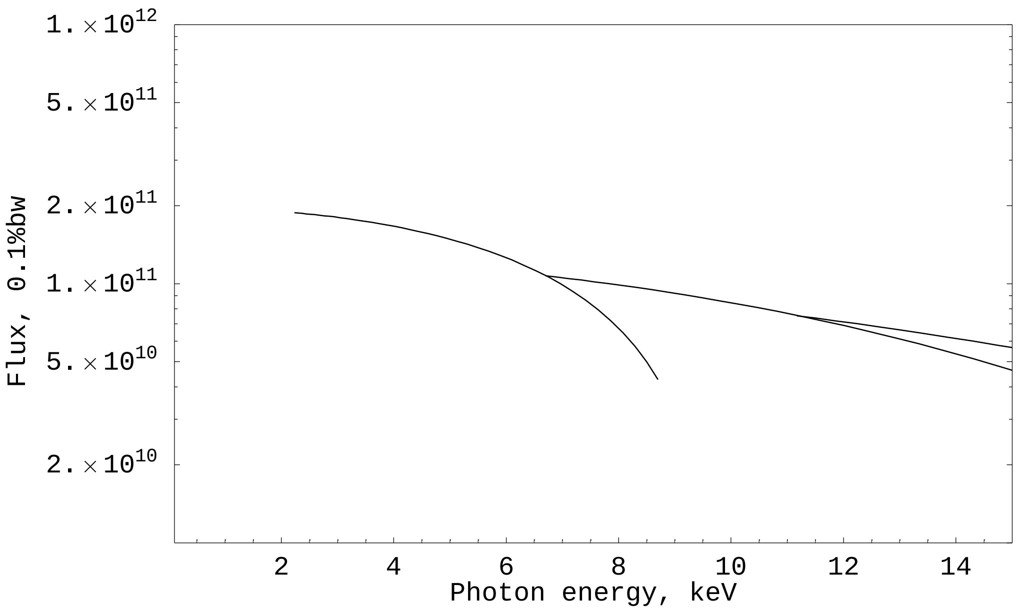

Figure 8. Kmax=2.6, period=1.4 cm (Gap=3 mm, Bpeak=2 T); (compare with Figure 3 and 8)

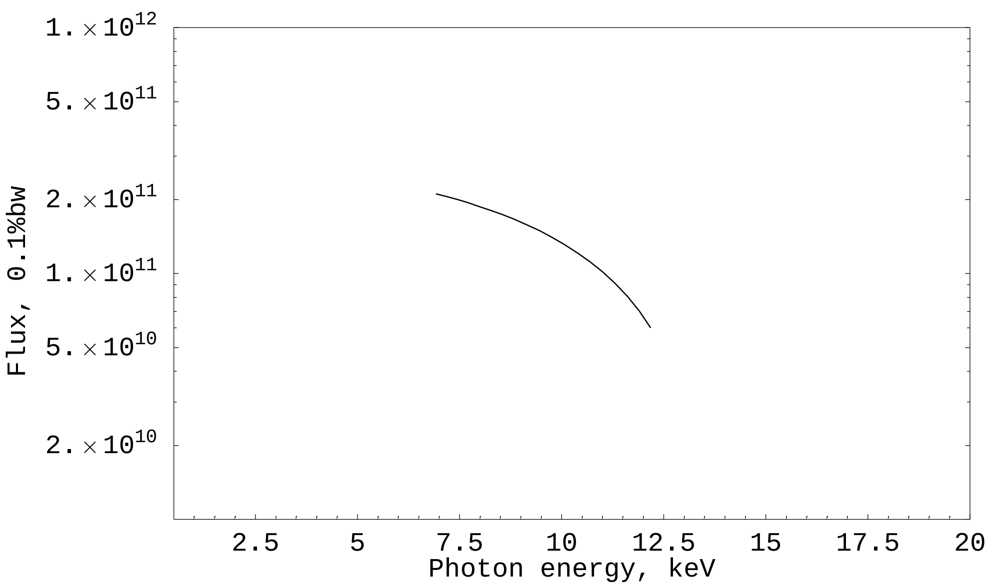

Figure9. Kmax=1.4, period=1.0 cm (Gap=3 mm, Bpeak=1.5 T); (compare with Figure 4 and 8)

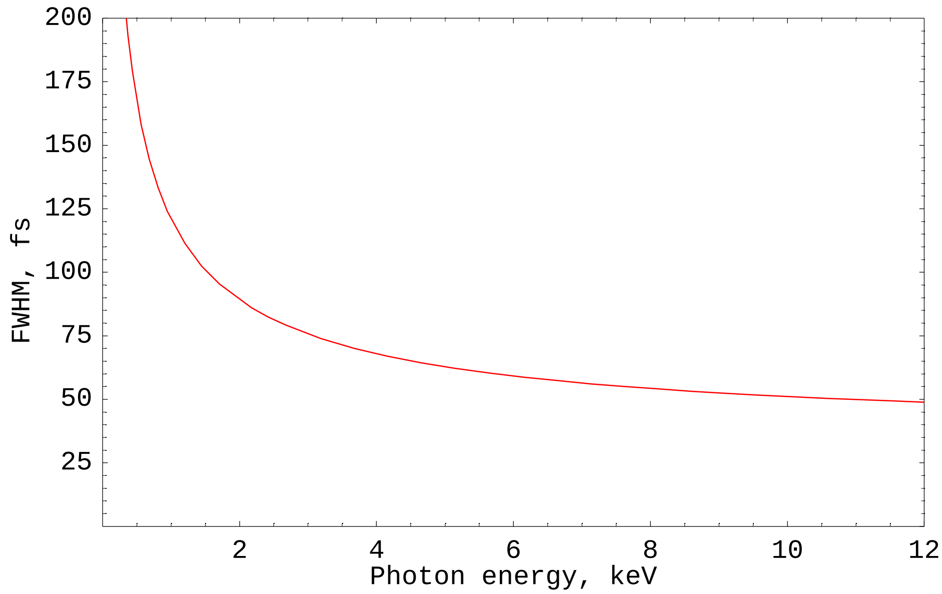

Figure 15. Beta_rf = 50m, Urf=10 MV, tilt angle = 140 microrad